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(71) Applicants Ashford Supplies Ltd., 942 Brunette Avenue, Coquitlam, British Columbia, Canada
(72) Inventor Dennison John Pickering
(74) Agents Page, White & Farrer, 27, Chancery Lane, London WC2A 1NT

(54) A temporary retaining system for an excavation

(57) A temporary retaining system for an excavation to restrain a cut face (2) of the excavation while a permanent structure is being built. The system comprises a flexible membrane able to withstand tension located against the cut face. The flexible membrane may be formed of metal mesh (4), lined with a lining sheet (8) to prevent material falling through the mesh. The metal mesh may comprise rectilinear steel wire mesh with the wires welded together where they cross. The lining sheet is preferably of polyethylene.

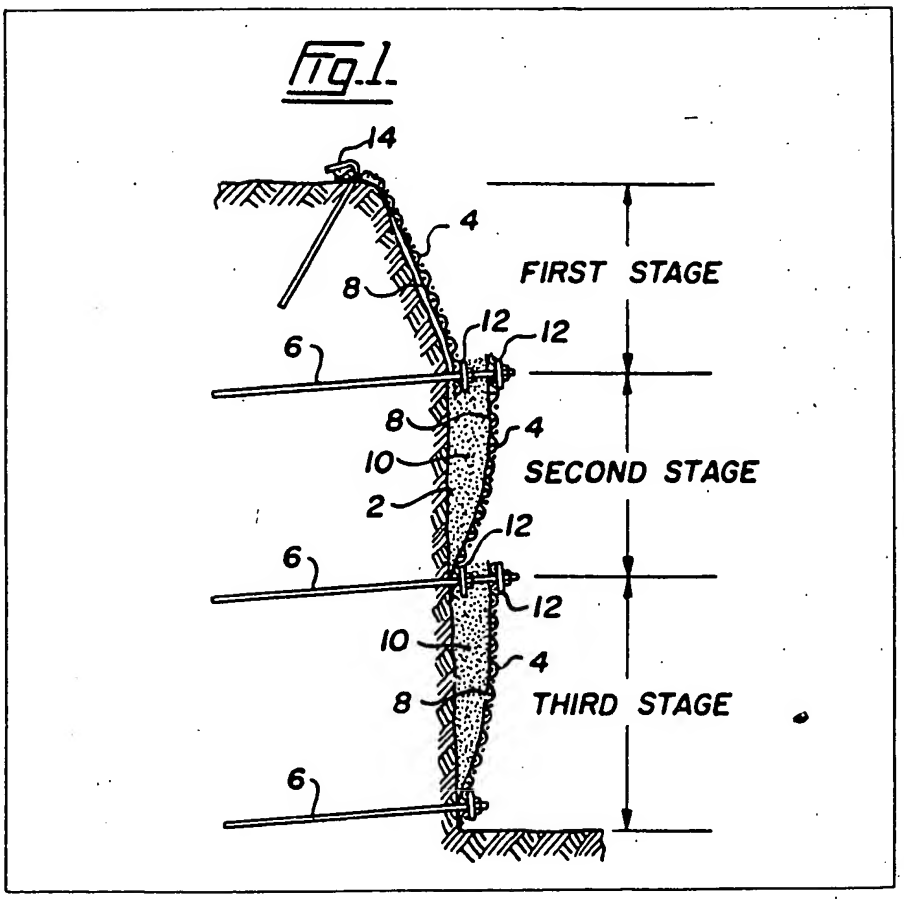

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Fig. 1.

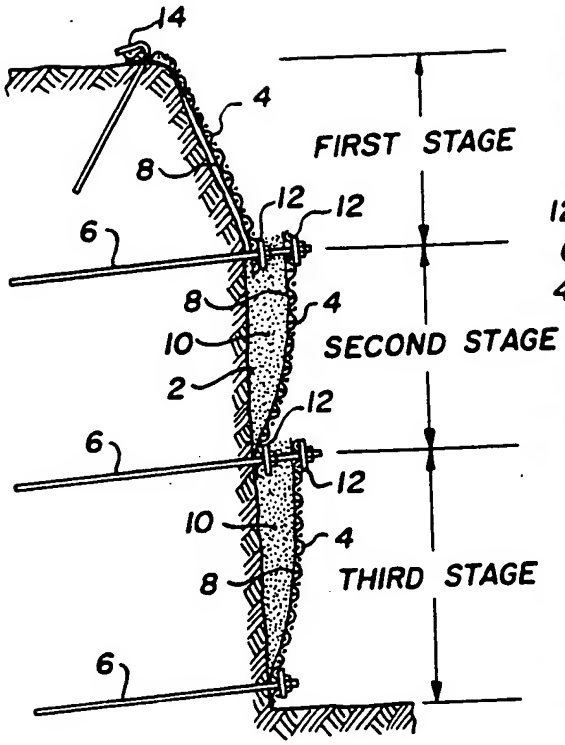

Fig. 2.

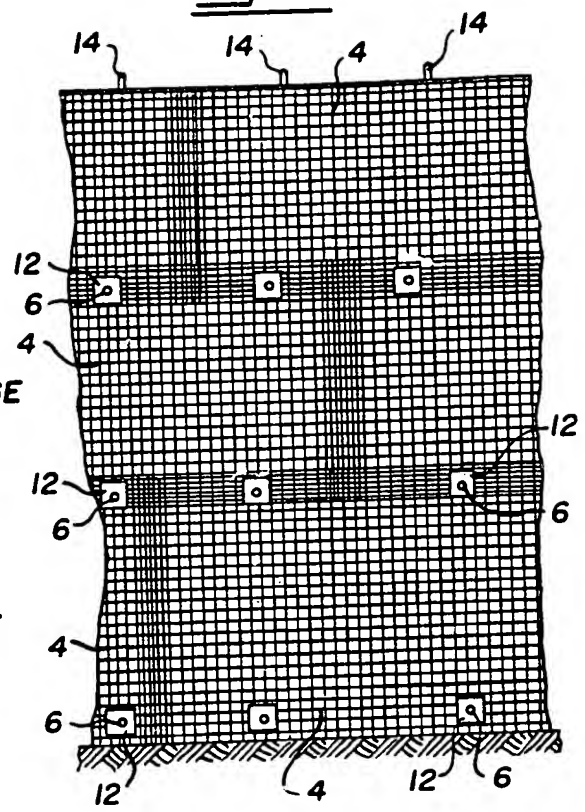

Fig. 3.

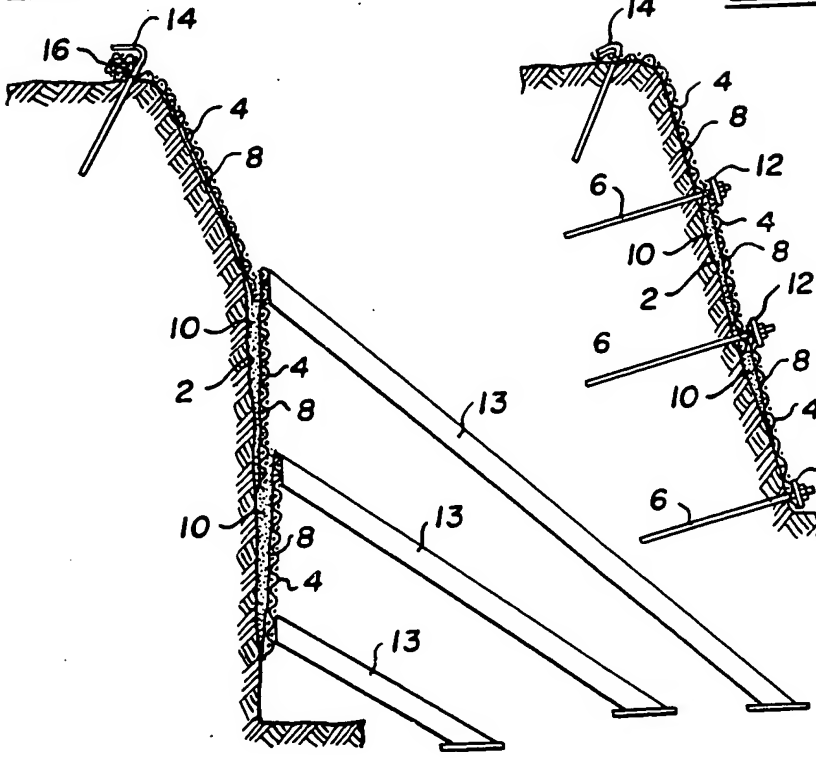

Fig. 4.

SPECIFICATION

A temporary retaining system for an excavation

This invention relates to a system for temporary support for an excavation face, to a method of constructing a system for temporary support and to a method of facilitating excavating by providing temporary support for cut faces until permanent work have been constructed.

Particularly in the construction of large buildings, considerable excavation may be required for the foundations or basements of the building. The excavated face must be retained as in many cases it will tend to slip into the excavation. The ground is an extremely variable material. In undertaking an excavation it is for the engineer to assess the support required from a shorting system to ensure that anchors, or struts of sufficient length, strength and quantity are provided, that the connections are adequate to provide the necessary support, and that adequate support is provided to the cut face between the anchors or struts.

The prior art known to applicant includes United States Patents 3,638,435 issued to Mason on February 1st, 1972; 3,802,204 issued to Mason on April 9, 1974 and reissue 28,977, reissued September 28th, 1976 at a reissue of the above United States Patent 3,638,435.

All the above patents to Mason show the formation of a retaining wall that consists of a skin of concrete. An array of rows and columns of dowels or tendons extends from the skin into the embankment supported by the retaining wall. A row of wale beams at the junction of the dowels and the face of the skin tie the components of the retaining walls together.

In the reissue patent it is indicated that the whale beams may not be essential. The reissue patent indicates that in certain circumstances, for example where the soil is sufficiently firm or where the excavation is relatively shallow, the concrete wale beams are unnecessary.

However, Mason invariably uses pneumatically applied concrete and furthermore always reinforces that skin of concrete. The application of pneumatic concrete is expensive and requires considerable skill. The provision of the concrete at the site of the excavation and the time required for the concrete to set can produce delays in supporting the earth face and in the construction schedule.

The present invention seeks to produce a retaining system and a method of constructing a retaining system that is cheap, uses material that can easily be stored on the site and yet is able to provide the necessary mechanical strength. In particular the use of pneumatically applied concrete is not required.

Accordingly in a first aspect, the present invention is a temporary retaining system for an excavation to restrain a cut face of the excavation while a permanent structure is being built, said system comprising: (a) a flexible membrane able to withstand tension; and (b) means to locate the flexible membrane against the cut face.

The flexible membrane provides tensile strength but little resistance to bending and is retained by a regular or irregular grid of point on line supports. In order to provide the tension by which the membrane affords support, it is necessary either to let the sides of the excavation bulge against the membrane between point or line supports or to introduce additional material as packing between the membrane and the cut face of earth. The membrane may be made up of individual sheets and each individual sheet may cover only a portion of the height of the cut, protection of the full height being achieved by a series of individual sheets one above another. Where this is so, to facilitate placing of packing material, it may be desirable to hold the individual sheets of which the membrane is formed, away from the earth face at their top edges and close to the face at their bottom edges. By this means convenient openings are formed in the membrane for addition of packing material.

The flexible membrane can be formed of a variety of materials or combinations of materials. A suitable combination has been found to consist of sheets of steel mesh lined with sheets of fabric or synthetic resin. The steel mesh transfers the forces from the supports over the area of the cut face and the fabric or synthetic resin lining sheets prevent material from falling through the openings in the mesh. Generally speaking sheets of steel mesh available as reinforcement for concrete, for example under the trade mark Weldmesh, have proved useful. That material comprises steel wires overlaid to produce a rectilinear mesh and welded or otherwise joined together at the junctions.

A particularly preferred lining sheet is polyethylene. A preferred packing material is sand. Like the mesh sheets both these materials are generally available on building sites.

All the aforementioned materials are only examples of suitable materials. The present invention requires only that the materials forming the membrane should have adequate flexibility and tensile strength and be of such a texture that the soil does not slip through. The packing material may be omitted as unnecessary on occasions.

Where any of the material forming the membrane is formed of individual sheets, the continuity of the membrane must be assured where necessary by sufficient overlap at adjacent sheet edges or by clipping or otherwise attaching the sheets to neighbouring sheets above, below or to the side, as determined by the designer of any given installation.

The regular or irregular grid of point supports for the membrane may consist of anchor plates attached to the exposed ends of tendons drilled and fixed into the cut face of earth, the plates being large enough to distribute the force in the tendon to the membrane. Alternatively they may consist of struts, supported in the excavated area or of other structural support. The alternative regular or irregular grid of line supports for the

membrane may consist of beams spanning between point supports of any of the types already described.

In a further aspect the invention is a method of constructing a retaining system for an excavation to restrain a cut face of the excavation while a permanent structure is being built, said method comprising locating a flexible membrane, able to withstand tension, against the face; and locating the flexible membrane at least at its top and its bottom to enable it to withstand tension.

A preferred method of forming the membrane is to hang a lining sheet over the face and then position a mesh sheet, spaced as desired. When the packing material is added it presses the lining sheet against the mesh sheet so that together they form a membrane.

In yet a further aspect the present invention provides a method of excavating comprising excavating a first wall section; positioning a flexible membrane able to withstand tension against the first wall section; locating said flexible membrane in position; excavating a second wall section, below the first; positioning a flexible membrane able to withstand tension against said second wall section; locating the flexible membrane in place against the second section; forming further wall sections to the required depth and positioning flexible membranes able to withstand tension against those further wall sections; and locating a flexible membrane in position against each cut face before proceeding to the lower section.

The regular or irregular grid of supports for the membrane is installed by a safe and convenient method, either as formation of the membrane proceeds or wholly or partially in advance of or following after formation of the membrane.

In the above methods the lining and mesh sheets which form the membrane need not deliberately be spaced from the cut face and the cut material is permitted to bulge against the material. Alternatively a packing material for example sand, may be deliberately introduced.

Aspects of the invention are illustrated, merely by way of example, in the accompanying drawings in which:

Figure 1 is a cross section of a retaining structure according to the present invention;

Figure 2 is an elevation of the structure of Figure 1;

Figure 3 is a cross section of a further aspect of the invention; and

Figure 4 illustrates a further aspect of the invention.

All the drawings illustrate a retaining system for an earth face 2 comprising mesh sheets 4 each of which may be held at least partially away from the face 2 to define a space between the mesh 4 and the face 2. There are tendons 6 extending into the face 2 to hold the mesh sheets 4 in the required position. A lining sheet 8 for example of polyethylene, is supported against the mesh sheets 4 in the spaces. Packing material 10, preferably sand, fills the spaces.

Figure 1 illustrates an aspect of the invention in which the mesh sheets 4 are held away from the face 2 at their tops and close to the face at the bottoms to define an open topped recess to contain the packing material 10. This system facilitates the introduction of the packing material.

As illustrated each mesh sheet 4 overlaps any neighbouring sheet 4 to the side (see Figure 2) or above (see Figure 1). The tendons 6 are arranged at the upper and lower edges of the mesh sheets 4 to locate them. Additional tendons, not at the edges of the sheets may be used. There are anchoring plates 12 at the end of each tendon 6 to assist in locating the mesh 4. In the embodiment of Figure 1 anchoring plates 12 are positioned close to the face 2 at the bottom of one sheet 4. Then the same tendon 6 will have a second anchoring plate 12 on it, located further from the face to fix the upper edge of the lower overlapping mesh sheet 4. The tendons 6 are, generally, angled into the face 2 to make them more stable.

The following comments should also be noted concerning the drawings:

In Figures 1, 3 and 4 the top stage is shown sloped because the top is usually the least stable; it often comprises disturbed or loose soil. However, the slope is not essential. The whole face may be sloped from top to bottom and if there is room it will probably be in the interest of additional security. Figure 4 illustrates the sloping of the whole face.

The anchor plates 12 may take the form of horizontal or vertical or diagonal beams. If required, there can be a plurality of sheets 4 or sheets 8 with subsequent sheets superimposed on the first sheet.

In Figure 3 the retaining structure stops short of the bottom of the excavation. This is permissible if the cut or excavation runs into a material that is stable without shoring, for example, rock.

As illustrated in Figures 3 and 4, where there is little space between the intended permanent structure and the face 2, one anchor plate 12 may be used. This of course, makes the insertion of the sand difficult but is economical of space.

Figure 3 illustrates a variation where struts 13 are used in place of the tendons 6.

In forming a one stage retaining system according to the present invention a lining sheet 8 and a mesh sheet 4 are located against the face 2, and may be spaced from the face 2 to define a recess between the sheets 4 and 8 and the face 2. The packing material 10 is then poured into the recess, between the face 2 and the sheet 8.

Figure 1 illustrates a method of excavating in which the procedure is as follows. Starting at ground level the excavation is carried out to the first stage as illustrated in Figure 1. Each stage is, generally speaking, the height that will stand unsupported at least for sufficient time to allow the retaining wall according to the present invention to be constructed against it. However, in stable ground the criterion may be the height called for by the designer for other reasons or the maximum available width of mesh sheet 4 less the

required overlap.

It is usual to slope at least the first stage because, as indicated above, the upper level of the ground tends to be unstable. A lining sheet is located against the face 2 of the first stage and a metal mesh 4 positioned over the lining sheet 8. The upper edge of the mesh 4 and of the lining sheet 8 are located by a hook 14 either alone see Figures 1 and 4, or by wrapping the top around a timber curb 16 and also using a hook — see Figure 3. Details of the arrangement at the top depend on whether it is desired to maintain an opening at the top of the lining sheet to pour sand or other packing material through the mesh and down behind the lining, or whether packing material is to be omitted, at least at the top. The bottom of the lining sheet 8 and mesh 4 are located by driving a tendon 6 into the face 2 at the bottom of the first stage.

Once the first stage is complete the excavation is carried out to the second stage depth, using the criteria as defined above. In the embodiment of Figure 1 the lining sheet 8 and the metal mesh 4 are located at the top of the first stage remote from the face 2 but are located at the bottom of the second stage close to the face 2. The tendon 6 at the bottom of the first stage becomes the tendon also used in locating the top of the second stage mesh 4. An anchor plate 12 is positioned on the tendon or, if required, a beam. The anchor plate 12 is located at the bottom of the second stage, on the drilled or driven tendon 6. The packing material 10 is then introduced into the recess so formed.

This procedure is repeated until an excavation of the requisite depth is formed.

The top edge of the first stage may be secured by means, other than those shown. For example wire rope bridles or horizontal beams may be used.

In constructing the retaining structure the sheets 4 that overlap are preferably clipped to each other at their sides. The use of clips at the edges of the mesh sheet develops tensile strength of the mesh by making the mesh behave as on continuous sheet. However, this idea is not essential to the invention. A simple overlapping and wire binding of the sheets at their edges is normally sufficient.

The present invention provides a cheap yet strong retaining wall. The tensile strength of the metal mesh sheet 4 in the preferred embodiment acts in conjunction with the polyethylene sheets 8 to form a membrane strong enough to support the cut face 2 between anchor plates 12 or anchor beams.

When used, the packing material 10, for example, sand, positioned between the membrane and the face 2 develops the strength of the membrane and transfers the sustaining pressure to the face 2. The particulate material 10 permits free drainage during construction and provides a filter zone to inhibit intrusion of silt into permanent, free-draining backfill around the finished structure.

Unlike heavy timbers which are sometimes employed to support a cut face between beams, the materials used for the present invention do not lose volume as they disintegrate with time. Therefore they can be left in place without the fear that voids will develop subsequently in the soil surrounding the building.

Unlike retaining walls formed of concrete, the membrane used for the present invention develops its full strength as soon as it is installed.

CLAIMS

1. A temporary retaining system for an excavation to restrain a cut face of the excavation while a permanent structure is being built, said system comprising:

(a) a flexible membrane able to withstand tension; and

(b) means to locate the flexible membrane against the cut face.

2. A system as claimed in Claim 1 in which the flexible membrane is formed of metal mesh, lined with a lining sheet to prevent material falling through the mesh.

3. A system as claimed in Claim 2 in which the metal mesh comprises rectilinear steel wire mesh with the wires welded together where they cross.

4. A system as claimed in Claim 2 or Claim 3 in which the lining sheet is of polyethylene.

5. A system as claimed in any of Claims 1 to 4, in which the tensile strength of the membrane is developed by allowing the cut face to move upwardly against it.

6. A system as claimed in any of Claims 1 to 4, in which the tensile strength of the membrane is developed by placing packing material between the membrane and the cut face.

7. A system as claimed in Claim 6, including spaces formed to facilitate the introduction of the packing material.

8. A system as claimed in Claim 6 or Claim 7, in which the packing material is sand.

9. A system as claimed in any of Claims 1 to 8, in which the means to locate the flexible membrane against the cut face comprises tendons driven into the cut face with anchor plates on the outer end of each tendon.

10. A system as claimed in any of Claims 1 to 8, in which the means to locate the flexible membrane adjacent the cut face comprises a plurality of struts extending outwardly of the face to retain the flexible membrane in position.

11. A temporary retaining system for an excavation to restrain a cut face of the excavation while a permanent structure is being built, the system comprising:

support sheets each held at least partially away from the face to define a space between the support sheet and the face;

means to hold the support sheets in the required position;

a lining sheet held against the support sheets in the space;

the support sheet and the lining sheet co-operating to form a flexible membrane able to

withstand tension; and

packing material in the space.

12. A system as claimed in Claim 11 in which the support sheets comprise rectilinear steel wire mesh with the wires welded together where they cross.

13. A system as claimed in Claim 11 or Claim 12, in which the individual support sheets are held away from the face at the top and close to the face at the bottom to define an open top recess.

14. A system as claimed in any of Claims 11 to 13, in which the means to hold the support sheets in position are tendons extending into the cut face with anchor plates on the end of each tendon to assist in locating the support sheets.

15. A system as claimed in any of Claims 11 to 14, in which each support sheet overlaps any neighbouring sheet to the side or above.

16. A system as claimed in Claim 14 or Claim 15, in which the tendons are arranged near the upper and lower edges of the support sheets to locate them.

17. A system as claimed in any of Claims 11 to 13, in which the means to hold the support sheets in position are struts extending outwardly of the face.

18. A system as claimed in any of Claims 14 to 16, in which the anchor plates are beams.

19. A system as claimed in Claim 15, in which the same tendons are used to locate the lower edge of an upper, overlapping support sheet and the upper edge of a lower, overlapping support sheet.

20. A system as claimed in any of Claims 11 to 19, in which the lining sheet is of polyethylene.

21. A system as claimed in any of Claims 11 to 20, in which the packing material is sand.

22. A method of constructing a temporary retaining system for an excavation to restrain a cut face of the excavation while a permanent structure is being built, said method comprising locating a flexible membrane, able to withstand tension, against the face; and

locating the flexible membrane at least at its top and its bottom to enable it to withstand tension.

23. A method as claimed in Claim 22, in which the flexible membrane is formed of steel mesh lined with a lining sheet adjacent the face.

24. A method as claimed in Claim 22 or Claim 23, in which the flexible membrane is located by driving tendons, with anchor plates at their outer ends, into the cut face.

25. A method as claimed in Claim 22 or Claim 23, in which the flexible membrane is located by positioning struts extending outwardly of the cut face and in contact with the flexible membrane to hold it in position.

26. A method as claimed in Claim 23 including incorporating a packing material between the cut face and the flexible membrane.

27. A method of excavating comprising excavating a first wall section;

positioning a flexible membrane able to withstand tension against the first wall section;

locating said flexible membrane in position;

excavating a second wall section, below the first;

positioning a flexible membrane able to withstand tension against said second wall section;

locating the flexible membrane in place against the second section;

forming further wall sections to the required depth and positioning flexible membranes able to withstand tension against those further wall sections; and

locating a flexible membrane in position against each cut face before proceeding in the lower section.

28. A method as claimed in Claim 27, in which location of the flexible membrane comprises positioning a lining sheet against the face; and

positioning a support sheet against the lining sheet and locating the support sheet in position, the support sheet and the lining sheet forming the flexible membrane.

29. A method as claimed in Claim 28, including incorporating a packing material between the face and the flexible membrane.

30. A temporary retaining system for an excavation, substantially as hereinbefore described and as illustrated in Figs. 1 and 2, Fig. 3, or Fig. 4 of the accompanying drawings.

31. A method of constructing a temporary retaining system for an excavation substantially as hereinbefore described and as illustrated in Figs. 1 and 2, Fig. 3, or Fig. 4 of the accompanying drawings.

32. A method of excavating, substantially as hereinbefore described and as illustrated in Figs. 1 and 2, Fig. 3, or Fig. 4 of the accompanying drawings.

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